SPD4121 HVAC Technology for Plumbing Engineers

Experiment 1: Study of Thermal Comfort and Indoor Environment

Objectives

- To assess thermal comfort and quality of indoor environment in building spaces.
- To study the principles of thermal comfort and important parameters.

Introduction

Thermal comfort is that condition of mind which expresses satisfaction with the thermal environment. It is a personal experience and is influenced by a combination of environmental factors and personal factors. When people are dissatisfied with their thermal environment, not only is it a potential health hazard, it also impacts on their ability to function effectively, their satisfaction at work, the likelihood they will remain a customer and so on. This experiment will give students an opportunity to strengthen what they have learned during the lectures, by investigating the related topics further and relating the learning to practical situations.

Theory

The major factors influencing thermal comfort can be divided into two categories: environmental factors and personal factors. Table 1 summarises those factors and Figure 1 shows the typical situation how environmental factors affect thermal comfort in buildings. Other contributing factors can include; access to food and drink, acclimatisation and state of health. In addition, thermal comfort will be affected by whether a thermal environment is uniform or not.

Table 1. Major factors influencing thermal comfort

Environmental factors	**Personal factors**
• Air temperature (dry bulb temperature) (°C) • Air velocity (m/s) • Radiant temperature (°C) • Relative humidity (%)	• Clothing (thermal insulation) • Metabolic rate (heat produced) • Well being generally and sickness

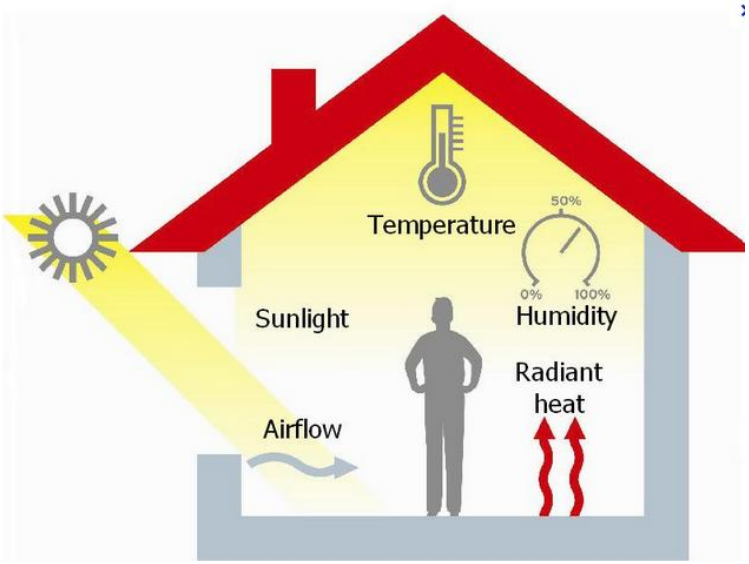

Figure 1. Environmental factors influencing thermal comfort

Methodology

Students shall form a team of 4-5 persons to carry out the experiment and investigation in a real building space (e.g. residential buildings and offices). They may choose any interior building space that they find interesting and have proper access to. By using the instruments and personal observations, they shall collect data and information to evaluate the characteristics of the building space and the key factors affecting thermal comfort and quality of indoor environment.

Measurement of the air temperature, relative humidity, carbon dioxide concentration level and air velocity shall be carried out using the data logger and anemometer borrowed from the laboratory. Students should pay attention to protect the instruments and avoid any damages. The measurement using the data logger should be taken for about 1-2 days in order to study the variation patterns of the indoor environmental parameters. Sample on-site measurement of the air velocity (say, 1 or 2 times) shall be conducted using the anemometer (the air velocity inside buildings is usually low and will not vary much). Since the amount of radiation heat gain to a subject is often small in indoor space (except places with sunlight or close to radiation heat sources like fire places or radiators), the radiant temperature is usually not very different from the air temperature.

Equipment and Instruments

- HOBO Bluetooth Low Energy Carbon Dioxide - Temp - RH Data Logger MX1102
  - Further information: http://www.onsetcomp.com/co2
  - Use the free HOBOmobile app (from App Store or Google play) to control the data logger
- Hot wire anemometer (for measuring air velocity)

Figure 2. HOBO MX1102 data logger

Results

The data measured by the HOBO data logger (air temperature, relative humidity, carbon dioxide concentration level) can be downloaded using the HOBOmobile app. Different data formats (e.g. Excel, CSV, graph image) can be used for the downloading.

After the experiment, the following information should be established to report the findings.

- Description of the building space and personal factors (e.g. clothing and activities)
- Clear presentation of the measurement data
- Summary graph(s) to show the characteristics of the indoor environmental parameters
- Analysis of thermal comfort and quality of indoor environment
- Comments on the satisfaction with the built environment

Laboratory Report

Each student should prepare their own report based on the data and information obtained during the experiment. While the results from the observations and measurements can be shared among the members in the same student group, each student shall generate information to show his/her own understanding and ideas. Students making direct copy of the information in other's report (plagiarism), if found, will be disqualified.

The laboratory report in electronic PDF format shall be submitted via email to the instructor within TWO weeks after completion of the experiment. Late submission will receive reduction in marks.

References

ASHRAE, 2013. *ASHRAE Standard 55-2013: Thermal Environmental Conditions for Human Occupancy*, American Society of Heating, Refrigerating and Air-Conditioning Engineers, Atlanta, GA.

Auliciems, A. and Szokolay, S. V., 2002. *Thermal Comfort*, 2nd ed., Research, Consulting and Communications, Kangaroo Valley, NSW. [http://plea-arch.org/wp-content/uploads/PLEA-NOTE-3-THERMAL-COMFORT.pdf]

Fanger, P. O.,1970. *Thermal Comfort: Analysis and Applications in Environmental Engineering*, McGraw-Hill, New York.

ISO, 1995. *ISO 7730: Moderate Thermal Environments – Determination of the PMV and PPD Indices and Specifications for Thermal Comfort*, 2nd ed., International Organisation for Standardisation, Geneva, Switzerland.

Web Links

Thermal comfort in buildings - Designing Buildings Wiki
http://www.designingbuildings.co.uk/wiki/Thermal_comfort_in_buildings

Thermal Comfort Tool for ASHRAE-55 (UC Berkeley), http://cbe.berkeley.edu/comforttool/